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A study on the measures for regeneration of the local railway using Conjoint Analysis

Jun MITERA*
Yoshimi KAWAMOTO**
Yoshiaki HONDA***

Abstract. It is important to regenerate local railways for city planning, for this purpose, it is necessary to aim at community design surrounding railway stations. Then, in this research, we analyze the measures for regeneration of local railways by the conscious survey, and examined the combination of the measures using Conjoint Analysis.

1. Introduction

1.1 The background and the purpose of the study

Various traffic problems have arisen by suburban sprawl and progress of rapid motorization. In local city which depends mainly on a car, declining usage of public transportation is especially serious problems. The management of local railways is severe, and local railways became defunct in many regions. However, the role of local railways, such as reduction of environmental load, community design, and response to an aging society, is large. It is important to regenerate local railways for city planning. For this purpose, it is necessary to aim at community design surrounding railway stations.

About measures for regeneration of local railways, enterprises and administrations have taken the lead and many measures were determined. So, profitability was considered preferentially and the need of users was not taken in.

This study focused on Fukui City which has high car ownership ratio. We collected the measures for regeneration of the local railway and the measures were evaluated by the local residents. Finally, the combination of the measures which was suitable for the area was proposed.

1.2 Method of the study

Public transportation in the Fukui city was chosen as the subject of the study. We conducted the first consciousness survey to 3 study areas for the purpose shown below. 1) Grasp of resident consciousness to public transportation of Fukui. 2) Evaluation of the measure for regeneration of the local railway. In addition,

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* Jun MITERA, Graduate School of Engineering, University of Fukui,910-8507
** Yoshimi KAWAMOTO, Graduate School of Engineering, University of Fukui, 910-8507
*** Yoshiaki HONDA, Vice-President, University of Fukui, 910-8507

this study paid its attention to local railways which are mass transport and are possible reduction of environmental load. Then as the case study, the measures for regeneration of the local railway were extracted and we conducted the second consciousness survey. We worked out by Conjoint Analysis using the survey results. Finally the combination of the measures was proposed.

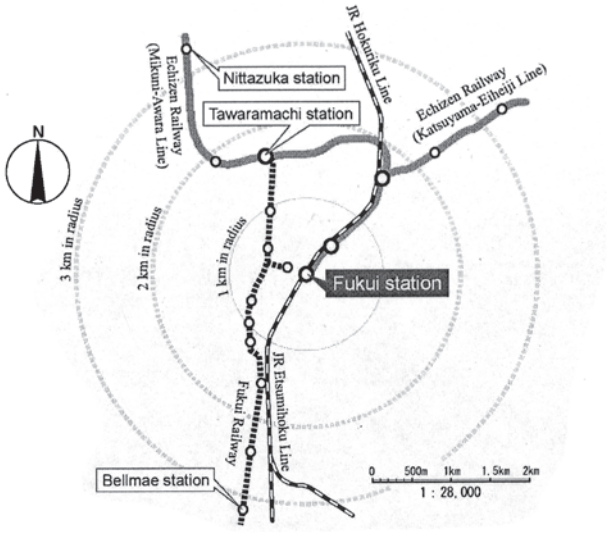

Fig.1 The study area's map

2. Evaluation of the measures for regeneration of the local railway

2.1 The outline of the first consciousness survey

Conventionally, administrations and enterprises judged proposal and applicability of measures. However, in various sectors, 'partnership' has been required. From a viewpoint of improvement in consciousness of life style, 'community design' by local residents and "participation" has become very important.

Therefore, this study aims at resident's consciousness for the necessity of public transportation and evaluation of the measures of the local railway.3 stations which were chosen as the subject of the study are shown in Fig.1. The outline of the first consciousness survey is shown in Table 1. In addition, the number of sample was made into 5% of accuracy, and carried out through random sampling from the Basic Resident Register.

Table.1 The outline of the first consciousness survey

Study Area	Bellmae	Tawaramachi	Nittazuka
method	mail-in survey		
period	March, 2004		
Population of the study areas	5,281	6,569	5074
The number of distribution	139	138	139
valid response	30 (21.6%)	27 (19.6%)	40 (28.8%)
content of question	1. The necessity for activation of public transportation		
	2. Satisfaction level of public transportation		
	3. Evaluation of the measure suitable for the study area		

The study areas were selected considering the reason as follows. 1) When now-defunct Keifuku Electric Railway had difficulty surviving in 2001, activity for continuation was taken place in the study areas, and consciousnesses of the residents are comparatively higher than other area about public transportation. 2) The study areas are located in urban area. The outline of the study areas are shown in Table 2

Table.2 The outline of the study area

		Bellmae	Tawaramachi*1)	Nittazuka
From Fukui station	distance (km)	3.5	1.3／3.7	6.4
	time (min)	12	4／9	14
	fare (yen)	220	180／150	240
Urban land use within 500m in radius		61%	80%	66%

*1) Because there was use of Fukui Railway and Echizen railway, the Tawaramachi station was shown as (Fukui Railway/Echizen railway).

2.2 The present evaluation of the public transportation in Fukui

The necessity for activation of public transportation is required from 90 percent of the local residents. Some reasons are shown as follows. 1) There is no lost time by traffic congestion. 2) Public transportation is required for transportation poors and elderly peoples. 3) Since traffic accidents decrease, the safety of transportation improves on road. Because use of car is impossible at snowfall, public transportation becomes very important transportation device for the local residents. However, when we actually investigated Occupancy rate of the railway, passenger volume has been decreasing quickly since 1995. Nevertheless the respondents feels the necessity for activation of public transportation, they do not actually use the railway.

Next, 'Likert Scale' was used for analysis about satisfaction level of public transportation. The result is shown in Table 3.

Table.3 Satisfaction level of public transportation

	Bellmae	Tawaramachi	Nittazuka
JR	0.172	−0.035	−0.088
Echizen railway	0.054	−0.004	−0.028
Fukui Railway	0.150	0.001	−0.119
Local bus	△ 0.325	−0.083	−0.165
Community bus	0.082	△ 0.379	▼−0.360
Taxi	−0.174	0.209	−0.031

△...high ▼...Low

Evaluation in the area around the Nittazuka station is relatively low in Table 3. On the whole, Evaluation had a difference among the areas. Even if a route exists in the area, evaluation is not necessarily high. For example, although evaluation of 'Echizen Railway Co., Ltd' in the area around the Bellmae station is the highest in the other areas, there is no route of 'Echizen Railway Co., Ltd' in the area (the radius of 500m centering on the station).

2.3 Evaluation of the measures by the residents in the areas around the stations

In order to prepare "the measures for regeneration of the local railway" for the first consciousness survey, the editing work of the measures was done based on the collection of ideas proposed by ROBA. "The ideas for activation of public transportation (made by ROBA)" are consisted of about 160 measures classified into six categories. Excepting similar measures and measures including concrete station's name, we selected the measures. Moreover, technical terms were changed to short and intelligible text, and we added explanation of technical terms and case examples to the survey sheets. After testing a huge number of the measures carefully, the 20 measures were selected. They were newly classified into four categories, such as "Operation and Vehicles"," Fare System", "Software Measure", and "Hardware Measure".

The first consciousness survey was conducted using the 20 measures. The residents choose the most suitable measure for the study area from the 20 measures and some measures suitable for the next. The score is as follows. The most suitable measure was counted to two points, suitable measures ware counted to one point. In order to compare the three study areas, the rate of score for a measure was calculated. The result is shown in Table 4.

Table.4 The rate of score for the measures (%)

classification	No	the measures for regeneration of the local railway	Bellmae	Tawaramachi	Nittazuka
Operation and Vehicles	1	Mutual entry	8.5	9.9	10.9
	2	Limited express (train), express train / Improvement of railway system	4.0	7.5	6.7
	3	Attractive facility, function, design, painting	4.0	2.5	4.6
	4	Introduction of LRV system	7.3	4.3	5.0
	5	The vehicles which can carry in a bicycle (Bicycle train)	7.3	8.7	8.4
Fare System	6	Reduction in fare / Common ticket、project ticket	10.7	8.1	9.2
	7	Discount ticket for railway	4.0	1.2	2.9
Software Measure	8	Route map / Railway timetable	5.6	3.7	2.9
	9	Railway timetable and related goods sale	1.1	1.9	0.4
	10	Cooperation with an event	5.6	6.2	6.3
	11	Public information	1.1	0.6	3.4
	12	Local neighborhood community association and a local volunteer manage a station.	1.7	3.1	0.8
	13	Improvement of the manners of passenger and staff	4.5	2.5	4.6
	14	Education about importance of public transportation	4.5	2.5	5.9
Hardware Measure	15	Relocation and new construction station	6.2	4.3	5.9
	16	Versatile use in station house	5.6	7.5	5.0
	17	Improvement of parking area for P&R	4.5	6.8	5.5
	18	Improvement of station square	5.6	6.8	5.5
	19	Improvement of pedestrian space around station / Put up a road sign	4.0	4.3	2.5
	20	Location of public facilities around station / Induce to locate around station for commercial facilities	4.0	7.5	3.4

In the area around the Bellmae station, "Fare System" showed higher rate of score for a measure than other classifications. "Operation and Vehicles" were the second higher. In the area around the Tawaramachi station, there is a lot of debate about mutual entry. Therefore, the rate of score for a measure of "Operation and Vehicles" was higher. Moreover, two measures of "Hardware Measure" were higher. The reason was considered the following two points. 1) The house of the Tawaramachi station has been superannuated. 2) And the request of reconstruction has come out from the local residents. In the area around the Nittazukka station, the rates of score for a measure of "Operation and Vehicles", and "Fare System" were higher. Overall, the rate of score for a measure of "Software Measure" which required long-range perspective and has indirect effect was lower, and the rate of score for a measure of "Operation and Vehicles" and "Fare System" which leads to direct use of the local railway for a short period was higher.

3. The proposal by the combination of the measures for regeneration of the local railway

3.1 Selection of the study area around the station

Here, the area around the station was selected as a case study, and the combination of the measures was proposed. The area around the Bellmae station was selected as a case study. Conjoint analysis was used as the technique of the combination of the measure, and we proposed the best combination for the case study

(The area around the Bellmae station). If any measure is important like this time, distinction of reciprocal importance cannot necessarily be performed well in many cases. Therefore, we decided to use Conjoint Analysis which can compare mutually two or more factors.

The method of Conjoint Analysis and the flowchart of the analysis are shown in Fig. 2. In order to conduct the second consciousness survey for Conjoint Analysis, the classification of the measures shown in Table 4 was set up with "factor", and the higher measures of score rate from each classification was extracted as "level" of each factor (Table 5). Evaluating about the optimal combination of the measures (hereinafter called profile), many profiles are needed. Since it is difficult for respondent to evaluate all profiles, we showed only 11 kinds of profiles by orthogonal array method. In addition, the whole sentence of Table 4 was shown to the respondents on the occasion of the survey. As respondents of the survey, we chose citizens' groups, students belonging to laboratory of city planning, and consultant firms. The reasons for selection are the following two points. 1) It is difficult for the citizen who does not use the railway to answer the questions. 2) Respondents can evaluate actually by extracting the object without making the whole users into parent population. In addition, we got 49 persons' valid responses (82%).

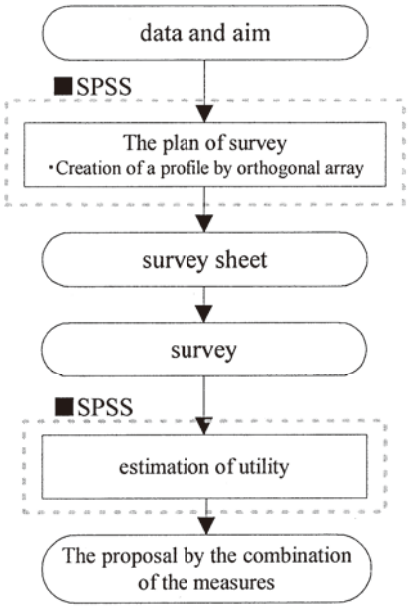

Fig.2 The method of Conjoint Analysis

We analyzed by using SPSS (software) based on the results of the second consciousness survey, and the optimal combination of the measures was proposed.

3.3 The proposal of the optimal combination of the measures for regeneration of the local railway

The following is the result of Conjoint Analysis. According to average importance of each factor shown in Fig. 3, "Hardware Measure" had the highest importance, and "Operation and Vehicles" had the second importance. In addition, both Pearson's product moment correlation coefficient (0.988) and Kendall's rank correlation coefficient (0.957) were very close to 1. Therefore, it became clear that the whole respondents fit the Conjoint model. Average utility value of each measures showing whether is evaluated by the respondents is shown in Table 6. Compared with other two factors,

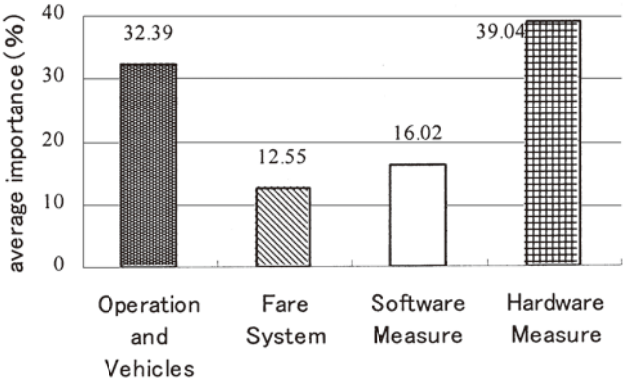

Fig.3 Average importance

Table.5 Factor and level

	Operation and Vehicles	Fare System	Software Measure	Hardware Measure
1	1. Mutual entry	6. Reduction in fare	8. Route map	15. Relocation and new construction station
2	4. Introduction of LRV system	7. Discount ticket for railway	10. Cooperation with an event	16. Versatile use in station house
3	5. Bicycle train			18. Improvement of station square

range value of "Operation and Vehicles ", and "Hardware Measure" was as large as 0.153. Especially, average utility value of "4.introduction of LRT system" and "18.station square improvement" was high. On the other hand, range value of "Fare System" and "Software Measure" was small.

Table.6 Average utility

classification	measure	Average utility	utility
Operation and Vehicles	1. Mutual entry 4. Introduction of LRV system 5. Bicycle train	-0.046 -0.053 0.100	0.153
Fare System	6. Reduction in fare 7. Discount ticket for railway	0.045 -0.045	0.09
Software Measure	8. Route map 10. Cooperation with an event	0.045 -0.045	0.09
Hardware Measure	15. Relocation and new construction station 16. Versatile use in station house 18. Improvement of station square	-0.067 -0.019 0.086	0.153

R: range

The priority of profiles is shown in Table 7. The combination of the measures with high ranking expresses desired profile. "4.introduction of LRT system" which belongs to "Operation and Vehicles" occupied almost all profiles. Therefore, "4.introduction of LRT system" was currently demanded strongly.

Table.7 Priority of profiles

rank order	No.1	No.2	No.3
Operation and Vehicles	4. Introduction of LRV system	4. Introduction of LRV system	4. Introduction of LRV system
Fare System	6. Reduction in fare	6. Reduction in fare	7. Discount ticket for railway
Software	8. Route map	8. Route map	8. Route map
Hardware	18. Improvement of station square	18. Improvement of station square	18. Improvement of station square
utility	3.587	3.507	3.497

4. Conclusion

In this study, the following results were obtained.

1) The local resident's consciousness to public transportation has been grasped using the consciousness survey.
2) The measures for regeneration of the local railway were evaluated using the result of the first consciousness survey. Consequently, the consciousness difference among the study regions became clear.
3) Using the analysis of 2, the second consciousness survey was conducted for experts involved in community design.

The priority for the combination of the measures was determined as a result of Conjoint Analysis, and we proposed the optimum combination of the measures.

Acknowledgment

In addition, we return thanks to the residents, ROBA, and experts who cooperated in the survey